APPENDIX J: IDENTIFICATION OF HISTORICAL CHANNEL MIGRATION ZONE

We define the historical channel migration zone as a boundary encompassing areas of historical channel occupation over a particular timeframe. This appendix explains how we delineated the historical channel migration zone (HCMZ) for the Quinault River study area, and what timeframe each boundary represents.

1.1 Definitions and Terminology

A historical channel migration zone represents an area where the main river channel occupies and transports sediment and woody debris within an established timeframe in history. The area within the HCMZ is dynamic and continually changing form during floods. It represents the area where the majority of coarse sediment (sand, gravel, and cobbles) and woody debris has been transported during at least the last century. The active channel represents the low flow river channel and gravel bars that are frequently reworked during floods and over which bedload is transported. The active channel is free of mature woody vegetation. The active floodplain was built by lateral migration of the active channel. It includes side channels, secondary or flood-flow channels, and low-elevation vegetated surfaces that are frequently inundated by floods. The area outside of the HCMZ boundary can still be inundated, but it takes larger floods to overtop the surfaces that form the HCMZ boundary.

For our study of the Upper Quinault River, we were most interested in river occupation over the last century. We delineated the 2002 HCMZ boundary, which is believed to represent a time period of at least a hundred years based on documentation of channel position between 1906 and 2002. It has been documented that surfaces binding the HCMZ boundary in the Quinault River valley range in age between a few hundred to several thousand years old (see radiocarbon dating appendix). These ages represent the minimum age during which these surfaces were last occupied by the Quinault River or inundated by the historic, larger Lake Quinault (see geology appendix). Because these surfaces are greater than a hundred years old, the "HCMZ" boundary likely encompasses a longer time interval than a hundred years of active channel and floodplain occupation, but the exact time interval is unknown.

The HCMZ is not a fixed boundary, and can expand and contract during different periods in the river's history. Thousands of years ago the river occupied much of the Upper Quinault River valley between the Forks and the present location of Lake Quinault. This boundary gradually narrowed as the river incised into the valley. Many of the present terraces have smaller channels cut through them that provide evidence for times in history when the river occupied a larger portion of the valley bottom. Historic channel migration zones associated with geologic time scales were not done for this study, but we did map geologic surfaces. These surfaces can be used to get a feel for the portion of the valley the river occupied during Holocene and Pleistocene time periods. The geology appendix of our report provides more information about these surfaces and how they are linked to the recession history of Lake Quinault.

Since at least 1939, the HCMZ boundary has continually expanded due to river erosion. The 2002 HCMZ can be bounded by terraces composed of glacial material (till, outwash, or lacustrine sediments) or alluvium, alluvial fans, bedrock, older lake deposits, or engineered bank protection (riprap, engineered log jam, bridge abutment, levees, road embankment). The 2002 HCMZ will continually expand in the future where the river runs against erodible material, particularly in areas that have been cleared of native riparian vegetation that help slow the rates of erosion. It was of interest to track how much and when the HCMZ boundary has eroded since 1939. For this reason, an interpretation was made using sequential aerial photography of where the 1939 and subsequent aerial photography year HCMZ boundaries were. The differences between the 1939 HCMZ and more 2002 HCMZ boundaries represent areas of bank erosion along the boundary since 1939.

The rate and extent of potential expansion of the 2002 HCMZ boundary can be interpreted by looking at historical rates measured between 1939 and 2002, by evaluating which surfaces are most susceptible for river erosion based on geologic controls and sediment transport capacity in the system, and by looking at where channels are currently dissected through the binding surfaces. Areas where the channels dissected through these surfaces have an upstream connection with the Quinault River pose the greatest risk for future channel avulsion. Erosion of the intermediate Holocene surface is thought to be at a greater risk for higher lateral rates of erosion than the higher elevation upper Holocene surface. Further evaluation of bank material properties in each geologic surface would need to be accomplished to refine predictions of future historic channel migration zone boundary erosion rates. Methodology that could be used as a guideline to estimate the risk of future erosion distances and rates of the historic channel migration zone is described in a report by the Bureau of Reclamation on the Hoh River in Washington State (Piety, et al, 2004), and in literature developed by the Washington State Department of Ecology (Abbe and Raff, 2003).

1.2 Methodology for Determination of Historical Channel Migration Zone

We developed a HCMZ boundary using the following steps:

1. Document active floodplain and river channel paths as observed in aerial photography between 1939 and 2002
2. Document geologic surfaces that bind the active floodplain
3. Delineate the 2002 historic channel migration zone boundary at the edge of geologic surfaces encompassing the 1939 to 2002 channel paths. Surfaces on the Quinault River were composed of Holocene and Pleistocene terraces, lake deposits, bedrock, and alluvial fans.
4. Document channel paths on historical maps from 1897, 1906, and 1929.
5. Expand the 2002 historic channel migration zone boundary to include these areas where there is evidence of a historical channel based on Lidar data collected in 2002 or from field work.
6. Field check results.

Analysis of historical aerial photographs and maps to document historical main channel paths and active floodplain areas. Historical channel paths show areas where the active channels have been in the recent past, which defined the 2002 HCMZ. Older channel paths are often still visible in the existing active floodplain as side and overflow channels. In other cases, development or logging activities have disturbed or filled in the older channel paths and floodplain making them undetectable from aerial photography. For the Quinault River, historical aerial photographs ranging from 1939 to 2002 were used, along with historical maps documenting channel position in 1897, 1906, and 1929.

Lidar Data from 2002 to verify the boundary of the HCMZ. This data was used to identify the boundaries of older surfaces, mapped as Holocene or Pleistocene in age, and low surfaces that show topographic evidence of old channels, such as narrow zones of lower or sparse vegetation on an otherwise densely vegetated surface. These low surfaces would be included in the HCMZ. On the other hand, high terrace surfaces that appear to be uncut by large channels would be excluded from the HCMZ. In some areas of the Upper Quinault, Lidar data revealed small channels dissected through the surfaces that bind the HCMZ.   These channels can be frequently inundated even when the binding surface is not, but were not considered part of the HCMZ unless there was evidence of the main channel occupying these areas between 1906 and 2002. These areas would likely be considered part of a channel migration zone associated with a longer historical timeframe, such as several hundred to thousands of years.

Field inspections to verify delineated terrace banks and confirm the location of the HCMZ boundary as defined from the Lidar data. Terrace banks were identified in the field to verify mapping done from aerial photography and maps. Where the location of the HCMZ boundary was questionable, low surfaces were investigated to determine if they contained evidence of frequent flooding and active channels. Frequent flooding would mean the surface was part of the active floodplain in the HCMZ as opposed to being a higher terrace that forms the HCMZ boundary. Characteristics looked for were overflow paths that were fairly unvegetated, debris backed up against woody vegetation, and fine sediment deposition.

1.3 Methodology for Defining the 1939 Historical Channel Migration Zone

It was desired to identify the HCMZ as far back in time as possible to quantify the amount and rate of terrace bank erosion that has occurred over time. The 1939 aerial photography was the oldest possible date to determine a HCMZ boundary. Unlike the determination of the 2002 historical channel migration zone, which integrates extensive field work and could incorporate field observations, the 1939 HCMZ was estimated solely on the basis of aerial photography and historical maps. An interpretation was made of the 1939 HCMZ based on the distinction between vegetation in the active floodplain (1939 HCMZ) and on terraces that bound the 1939 HCMZ. In general, the vegetation within the 1939 HCMZ is dense, appears of the same age or height, and is often discontinuous because of recently active side channels that have removed vegetation or have kept it from growing. The vegetation on the terraces that bound the

HCMZ is less dense and appears irregular, because individual trees are large enough to be visible and the trees are of differing species and heights. The original land survey maps from 1897 and 1906, and a USGS 1929 map document channel position prior to 1939. These maps have been found to be very accurate in many different watersheds studied and were used as a check on the 1939 HCMZ to ensure the boundaries identified as terraces were reasonable. In many cases the 1952 aerial photography was also used to check the 1939 HCMZ boundaries because the 1952 aerial photographs were flown at a lower elevation and had a higher level of clarity regarding vegetation and channel paths.

References

Abbe, T., and C. Rapp. November 2003. Final Draft: A framework for delineating channel migration zones, Washington State Department of Ecology, Ecology Final Draft Publication #03-06-027.

Piety, L., Bountry, J., Randle, T., and E. Lyon. July 2004. Geomorphic assessment of Hoh River in Washington State, Bureau of Reclamation, Department of Interior.